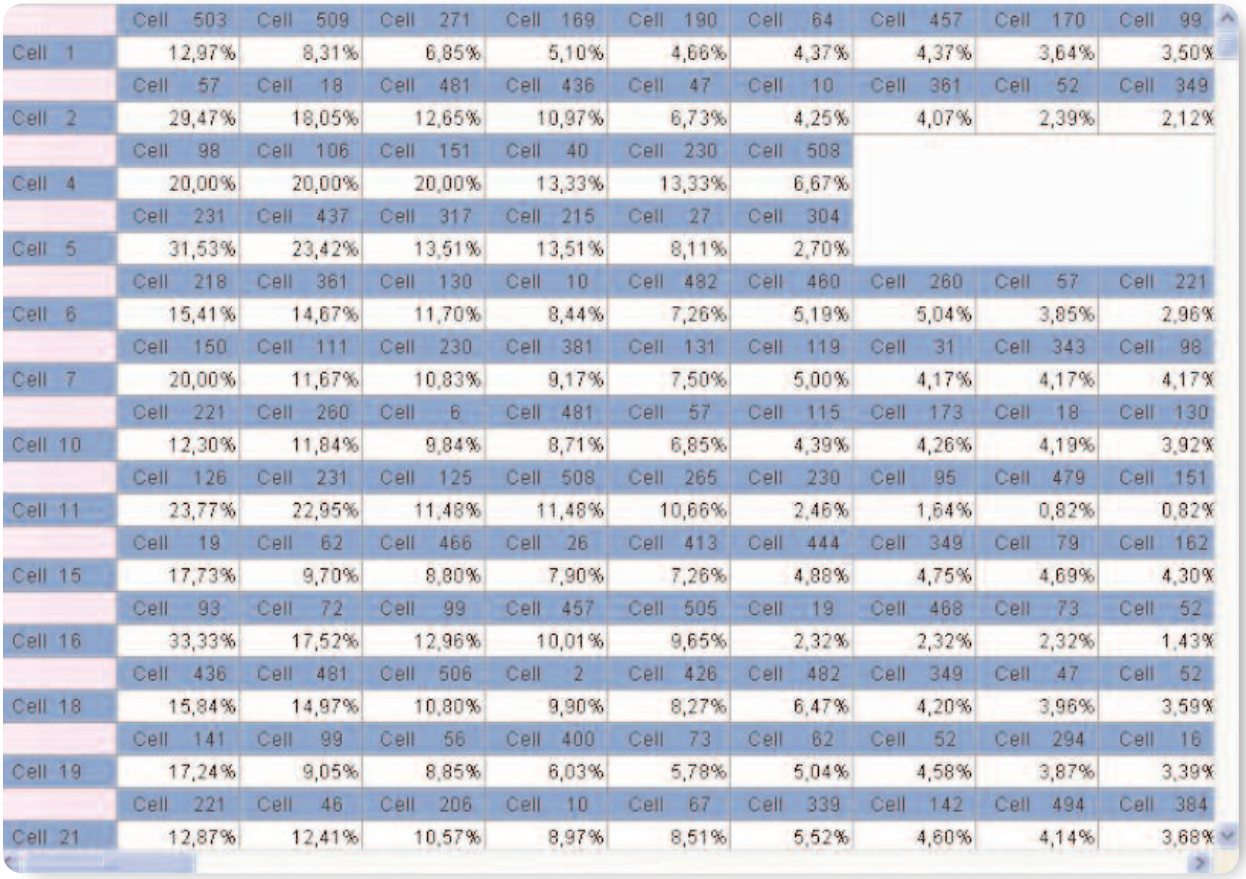
Complement Drive Test for UTRAN using a passive Protocol Monitor



	Cell 503	Cell 509	Cell 271	Cell 169	Cell 190	Cell 64	Cell 457	Cell 170	Cell 99
Cell 1	12,97%	8,31%	6,85%	5,10%	4,66%	4,37%	4,37%	3,64%	3,50%
	Cell 57	Cell 18	Cell 481	Cell 436	Cell 47	Cell 10	Cell 361	Cell 52	Cell 349
Cell 2	29,47%	18,05%	12,65%	10,97%	6,73%	4,25%	4,07%	2,39%	2,12%
	Cell 98	Cell 106	Cell 151	Cell 40	Cell 230	Cell 508			
Cell 4	20,00%	20,00%	20,00%	13,33%	13,33%	6,67%			
	Cell 231	Cell 437	Cell 317	Cell 215	Cell 27	Cell 304			
Cell 5	31,53%	23,42%	13,51%	13,51%	8,11%	2,70%			
	Cell 218	Cell 361	Cell 130	Cell 10	Cell 482	Cell 460	Cell 260	Cell 57	Cell 221
Cell 6	15,41%	14,67%	11,70%	8,44%	7,26%	5,19%	5,04%	3,85%	2,96%
	Cell 150	Cell 111	Cell 230	Cell 381	Cell 131	Cell 119	Cell 31	Cell 343	Cell 98
Cell 7	20,00%	11,67%	10,83%	9,17%	7,50%	5,00%	4,17%	4,17%	4,17%
	Cell 221	Cell 260	Cell 6	Cell 481	Cell 57	Cell 115	Cell 173	Cell 18	Cell 130
Cell 10	12,30%	11,84%	9,84%	8,71%	6,85%	4,39%	4,26%	4,19%	3,92%
	Cell 126	Cell 231	Cell 125	Cell 508	Cell 265	Cell 230	Cell 95	Cell 479	Cell 151
Cell 11	23,77%	22,95%	11,48%	11,48%	10,66%	2,46%	1,64%	0,82%	0,82%
	Cell 19	Cell 62	Cell 466	Cell 26	Cell 413	Cell 444	Cell 349	Cell 79	Cell 162
Cell 15	17,73%	9,70%	8,80%	7,90%	7,26%	4,88%	4,75%	4,69%	4,30%
	Cell 93	Cell 72	Cell 99	Cell 457	Cell 505	Cell 19	Cell 468	Cell 73	Cell 52
Cell 16	33,33%	17,52%	12,96%	10,01%	9,65%	2,32%	2,32%	2,32%	1,43%
	Cell 436	Cell 481	Cell 506	Cell 2	Cell 426	Cell 482	Cell 349	Cell 47	Cell 52
Cell 18	15,84%	14,97%	10,80%	9,90%	8,27%	6,47%	4,20%	3,96%	3,59%
	Cell 141	Cell 99	Cell 56	Cell 400	Cell 73	Cell 62	Cell 52	Cell 294	Cell 16
Cell 19	17,24%	9,05%	8,85%	6,03%	5,78%	5,04%	4,58%	3,87%	3,39%
	Cell 221	Cell 46	Cell 206	Cell 10	Cell 67	Cell 339	Cell 142	Cell 494	Cell 384
Cell 21	12,87%	12,41%	10,57%	8,97%	8,51%	5,52%	4,60%	4,14%	3,68%

Introduction

The introduction of third generation mobile networks has enabled network operators to offer a new range of service. Traditional voice offering is now complemented by services like video telephony, video streaming, video clip download and mobile web surfing.

The growth of the wireless market and the fierce competition between mobile network operators have created high customer expectations.

Customer satisfaction is key and mobile network operators have to be able to monitor and manage the quality of service they deliver to subscribers.

Approximately 70% of 3G network problems are related to radio interface issues. A careful optimization of the 3G RAN can have a huge impact on the ultimate quality of service perceived by 3G subscribers.

This Application Note focuses on Network Optimization using the "Cell Overlapping Matrix". We will discuss the method of Drive test, as well as passive monitoring techniques, using a protocol analyzer.

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The "Cell Overlapping Matrix"

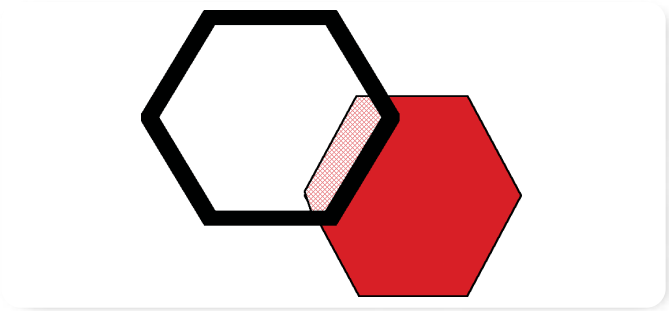
When a subscriber using her or his UMTS handset is moving around and reaches the boundary of the coverage area of one cell, it has to be guaranteed that:

– interferences from adjacent cells are not too high, otherwise the radio link quality and the user's perceived quality of service is deteriorated

– received power of adjacent cells is strong enough to allow reliable handover operations, otherwise user connections could be cutoff

These two contradictory actions, reducing interference and assuring reliable handovers, are challenges that network operators face when performing cell planning.

A common tool for radio network planners is the so called "Cell Overlapped Matrix". This matrix shows the interferences between every two given cells (identified by the scrambling code).



▸ **Figure 1.** *UMTS cell coverage areas overlap one another.*

For each cell (scrambling code i), one can see the influence of any other cell (scrambling code j). Interfering cells are usually adjacent to the cell under analysis. If a strong interferer who is not on the cell neighboring list is identified, no handover will be possible and uncontrollable interference can block cell throughput or cause extensive cell breathing. Knowing this, the matrix can also be used for scrambling-code plan optimization and as a checklist for neighbors plan.

Drive Test Activities

A special type of Cell Overlapped Matrix is typically built using drive test techniques which require dedicated software and hardware equipment.

Drive test software application enables:

- Control of all test parameters for the test session
- Phone and receiver measurements to be collected
- Selecting bands/channels to Test
- Selecting dialing parameters, call length

Collect result data from:

- Phone messages transmitted to and from the BTS
- Receiver measurements
- GPS time/date and location for each measurement

Set alarm thresholds

- Settings to notify user of a problem when it occurs
- Generally used in interactive mode while drive is being performed

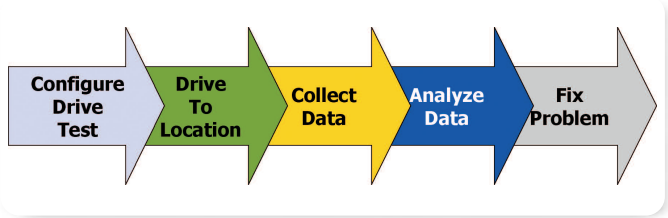
Store and organize the data in a large database

- A single short drive can produce 100MB+ of data depending upon settings

Post process the acquired data

- Replay the data
- Query for particular measurement values or events
- Provides the ability to decode individual BTS—phone messages & control events
- Geographically map data for context

Drive test consists of going through the following activities:



▸ **Figure 2.** *Drive Test Process*

First the drive test equipment needs to be configured. Sometimes a default configuration can be used but, in most cases, settings must be customized to ensure the correct parameters are collected.

Then engineers or technicians drive to the area where the problem exists, data collection is initiated, and the area of the network experiencing the problem is driven.

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▸ **Table 1.** *Cell Overlapped Matrix*

After the drive, the data is analyzed with post-processing software, and the Cell Overlapped Matrix is built.

Eventually corrective actions are carried out to fix the problem. Often, the result is reconfiguring the best cell neighbor list in the RNC.

Calculation of the Best Cell Neighbor Relation List Using Drive Test Data

The Cell Overlapped Matrix has a dimension of 512 rows x 512 columns.

The element in position (i,j) is defined as follows:

Ci,j = (# collected points where the scanner has detected scrambling code i and scrambling code j) / (# collected points where the scanner has detected scrambling code i)

The Ci,j ratio is normally expressed by percentage rate.

To define the best neighbor cell relation for each scrambling code and carry out corrective actions for network optimization, the following method is applied:

	Cell 503	Cell 509	Cell 271	Cell 169	Cell 190	Cell 64	Cell 457	Cell 170	Cell 99
Cell 1	12,97%	8,31%	6,85%	5,10%	4,66%	4,37%	4,37%	3,64%	3,50%

▸ **Table 2.**

Step 1

Select the row of the cell under investigation (e.g. SC=1 for Cell 1) and rank all percentages value along the row in ascending order:

Step 2

The row shows the most important scrambling codes for cell 1. They are in the order: 503, 509, 271, 169, 190, 64, 457, 170, 99.

Step 3

Compare the existing cell neighbor relation within the RNC database with the list reported in the Step 2 and add the missed cells.

Calculation of the Best Cell Neighbor Relation List Using Passive Monitoring of the Iub Interface With a Protocol Analyzer

Building “Cell Overlapped Matrix” using drive test technicians is very expensive and not optimized for the following reasons:

– Drive test techniques require many trips, costing around 500 euros per person per day; at least two technicians are involved and at least 2/3 campaigns need to be performed per region per network

– Comparing and updating the RNC database with neighbor relation meaurement data is manual and work intensive

– Accurate measurement can only be achieved in outdoor areas that are accessible by car. In big cities this represents only about 40% of the total area covered by the cellular service. The remaining 60% are indoor and pedestrian areas where it is not possible to drive.

The same information can be collected using passive monitoring techniques with a protocol analyzer that monitor the Iub interface between the NodeB and the RNC.

The Cell Overlapped Matrix can be generated by collecting Iub RRC measurement reports messages traveling on the Iub interface, which is a privileged monitoring point where radio interface measurements are constantly flowing from the handsets (RRC measurement reports).

The measurement report message reports radio information about 3 types of cells:

1. Active cells: cells included in the active set
2. Monitored cells: cells included in the measurement report but not included in the active set. The serving RNC (SRNC) ordered the UE to monitor these cells by sending a RRC Measurement Control message.
3. Detected cells: cells included in the measurement report despite the fact that UE was not ordered by SRNC to monitor these cells.

Using these RRC measurement reports, the "Cell Overlapping Matrix" can be calculated using the following algorithm:

c i,j =(# measurement report containing scrambling code i and scrambling code j.)

(# measurement report containing scrambling code i)

Conclusion

Network optimization activities are critical to ensure a proper radio network configuration. Since approximately 70% of the 3G network problems are related to the radio interfaces, good radio interface planning can have a great impact on the quality of service perceived by the subscriber and can make the difference when it comes to customer churn. Traditional drive test techniques can be complemented by passive monitoring techniques, enabling mobile network operators to reduce OPEX for network optimization. The investment in a protocol analyzer is exploited in the best way since protocol analyzers can be used not only for troubleshooting activities, but also for network optimization activities.

Contact Tektronix:

ASEAN / Australasia / Pakistan (65) 6356 3900
Austria +41 52 675 3777
Balkan, Israel, South Africa and other ISE Countries +41 52 675 3777
Belgium 07 81 60166
Brazil & South America 55 (11) 3741-8360
Canada 1 (800) 661-5625
Central Europe & Greece +41 52 675 3777
Central East Europe, Ukraine and Baltics +41 52 675 3777
Denmark 80 88 1401
Finland +41 52 675 3777
France & North Africa +33 (0) 1 69 81 81
Germany +49 (221) 94 77 400
Hong Kong (852) 2585-6688
India (91) 80-22275577
Italy +39 (02) 25086 1
Japan 81 (3) 6714-3010
Luxembourg +44 (0) 1344 392400
Mexico, Central America & Caribbean 52 (55) 56666-333
Middle East, Asia and North Africa +41 52 675 3777
The Netherlands 090 02 021797
Norway 800 16098
People's Republic of China 86 (10) 6235 1230
Poland +41 52 675 3777
Portugal 80 08 12370
Republic of Korea 82 (2) 528-5299
Russia, CIS & The Baltics 7 095 775 1064
South Africa +27 11 254 8360
Spain (+34) 901 988 054
Sweden 020 08 80371
Switzerland +41 52 675 3777
Taiwan 886 (2) 2722-9622
United Kingdom & Eire +44 (0) 1344 392400
USA 1 (800) 426-2200
USA (Export Sales) 1 (503) 627-1916
For other areas contact Tektronix, Inc. at: 1 (503) 627-7111

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